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BENTHIC MACROINVERTEBRATE AND HABITAT SURVEY OF BIG SPRING CREEK FERGUS COUNTY, MONTANA

1996

Prepared for

Montana Department of Environmental Quality
Planning, Prevention and Assistance Division
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INTRODUCTION

In an attempt to reduce non-point source water pollution in the Big Spring Creek watershed, land management practices have been altered as part of a demonstration project, one of several in Montana. The success of these projects is partly gauged by changes in the benthic macroinvertebrate communities of the area's streams, since the analysis of these communities can be related to a stream's biological health or integrity. Biological integrity has been defined by Karr and Dudley (1981) as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of natural habitat of the region." The framework for macroinvertebrate community analysis employed in these projects is an adaptation of the U.S. EPA's Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989), which is a multimetric approach.

A multimetric approach to bioassessment using benthic macroinvertebrates uses attributes of the assemblage in an integrated way to reflect overall biotic condition. Community attributes which can contribute meaningfully to bioassessment include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining components into an overall score reduces variance and increases precision of the assessment (Fore et al. 1995).

METHODS

Benthic macroinvertebrates were sampled from Big Spring Creek by personnel of the Montana Department of Environmental Quality (DEQ) on August 27, 1996. The traveling kick-net method described by Bukantis (1997) was utilized. Two samples were collected from each of five riffled reaches The resulting ten samples were numbered and sites described as follows:

1.1 and 1.2 Big Spring Creek below State Fish Hatchery Reach 1
2.1 and 2.2 Big Spring Creek at Burleigh Access
3.1 and 3.2 Big Spring Creek at Old County Farm Reach 2
4.1 and 4.2 Big Spring Creek at Lower Fishing Access (Hruska)
5.1 and 5.2 Big Spring Creek at Spring Creek Colony. Reach 3

Habitat parameters were scored using a DEQ-modified version of the U.S. EPA Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989).

Macroinvertebrate Sample Processing and Identification

Laboratory and data analyses were contracted to BlueStem Incorporated. Macroinvertebrate samples were processed using the U.S. Environmental Protection Agency's techniques for RBP III (Plafkin et al. 1989). Sample processing, enumeration and taxonomic identification of macroinvertebrate samples was subcontracted by BlueStem Inc. to Michael J. Mcbride.

Sample processing consisted of obtaining approximately a 300-organism subsample and was consistent with RBP III (Plafkin et al.1989). Organisms were enumerated and identified whenever possible to the taxonomic level specified in the Montana DEQ SOP (Bukantis, 1996).

The SOP requirements for subsampling and taxonomic resolution were strictly adhered to, deviating only when the quality of the specimen was lacking due to missing body parts needed for identification. When organisms were too immature to confidently take to the taxonomic level outlined in the SOP, they were more conservatively identified.

Following is a description of the subsampling procedure: Each sample was rinsed in a 0.5 mm sieve to remove preservative. The washed sample was then transferred to an appropriate size invertebrate sorting tray marked into square quadrants. Water was added to the tray to allow complete dispersion of the sample and even distribution of the organisms. Quadrants were randomly selected and organisms removed from each quadrant until the total number of organisms fell within the range of 270 to 330 (±10% of 300 organisms), or until there were no more invertebrates to remove, whichever occurred first. Any organism lying over a line separated by two quadrants was considered to be in the quadrant containing its head.

Data Analysis

Community structure, function and sensitivity to impact were characterized for each subsample with batteries of metrics similar to those used by McGuire (1995) in his earlier report on data from Big Spring Creek. Metrics generally include those recommended by DEQ for Montana Valley and Foothill Prairie streams. An internal reference approach is the major focus of the current analysis: a reference value for each metric was established based on the performance of that metric in all years studied. The best value in any year's data, if appropriate for the analysis, was chosen as the point of comparison, or reference value, for each metric used. Following the method established by McGuire in his 1995 report, separate internal references were created for the upper (Table 1) and lower (Table 2) reaches of Big Spring Creek, to accommodate the dramatic changes in stream character and benthic fauna as the stream flows farther from the predominant influence of the springs and groundwater upstream. Scoring criteria are, generally, the same as those used in 1995. The metric %Hydropsychinae of Trichoptera was added to the battery of metrics used to evaluate sites in the lower reach, below Lewistown, since organic and/or nutrient enrichment seemed to be indicated there.

Actual metric values for each replicate were averaged and the mean value was compared to the reference values to obtain metric scores (Table 4). Total metric scores were obtained by summing scores for all metrics, and an impairment classification and a use support category for each site was derived from this total score. For purposes of comparison, the data from studies of 1990, 1991 and 1994 were recalculated using the updated internal reference values, resulting in some changes to impairment classifications assigned in those years. Replicate samples from macroinvertebrate data gathered in 1990 were simulated using a modified bootstrapping technique so that comparisons of communities could be made across all the years studied. Taxa lists and metric results of the simulated samples are given in Appendix B. Trends in bioassessment scores across all the years of study are tabulated in Table 7.

Habitat assessment methods have been updated by DEQ since the earlier studies of Big Spring Creek, so scores from these studies were recalculated, and parameters and scoring were standardized to allow comparison among years. Recalculation resulted in changes in some of the condition categories assigned to sites in earlier years. Table 6 illustrates methods used to arrive at comparable habitat assessments for this study.

RESULTS AND DISCUSSION

Habitat Assessment

Figure 1 compares the results of standardized habitat assessments from all study years, using all parameters scored in each year. No habitat data were provided for the site below the State Fish Hatchery in 1996.

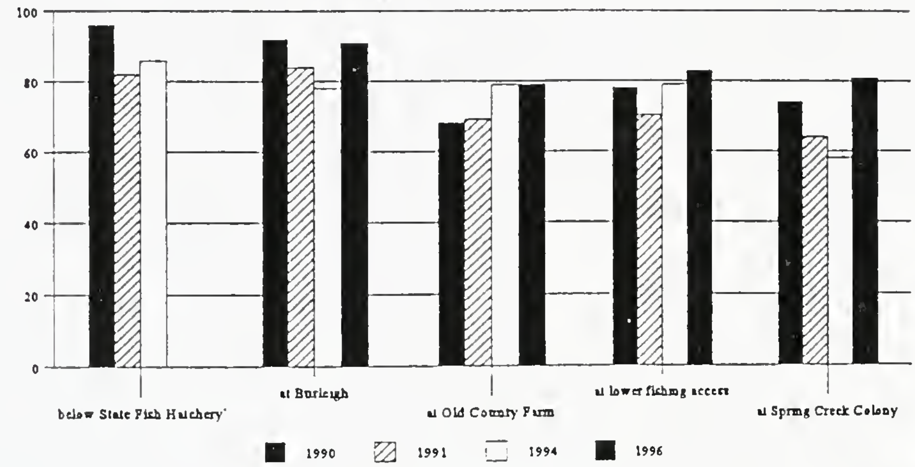


Figure 1. Total habitat scores. Big Spring Creek, 1990-1996.

Perceived habitat condition at three sites, Burleigh, the lower fishing access and at the Spring Creek Colony, improved from sub-optimal in 1994 to optimal in 1996; at the Old County Farm, habitat condition apparently was unchanged between those two years and the classification remained sub-optimal.

Scores for riparian width improved markedly at all sites for which 1996 data was available. However, increased sediment deposition was detected in 1996 at the Old County Farm site. Bank stability and extent of bank vegetative cover were perceived to have declined since 1994 at this site as well.

At the lower fishing access, decreased bank stability and a slight increase in embeddedness were noted, but the perceived increase in riparian width resulted in an improved total habitat score since 1994. Increased channel alteration was also detected.

The greatest improvement in perceived habitat quality between 1994 and 1996 was noted at the Spring Creek Colony site. Bank stability and vegetative cover improved, with an associated decrease in sediment deposition.

Macroinvertebrate Communities

Macroinvertebrate taxa lists, metric results and other information for each of the 1996 replicates are given in Appendix A.

The percent similarity between replicates ranged from 55% for those collected at the site below the State Fish Hatchery, to 78% for those collected at the Burleigh access. Mean percent similarity between replicates from all five sites was 58%. Relatively low similarity between replicates at the site below the State Fish Hatchery may be related to the large difference in subsample size used; there were 38% more organisms in replicate 1.1 than in replicate 1.2. Percent similarity between sites was calculated based on combined replicates and is displayed in Figure 2.

Figure 2. Percent similarity between sites. Big Spring Creek, August 27, 1996.

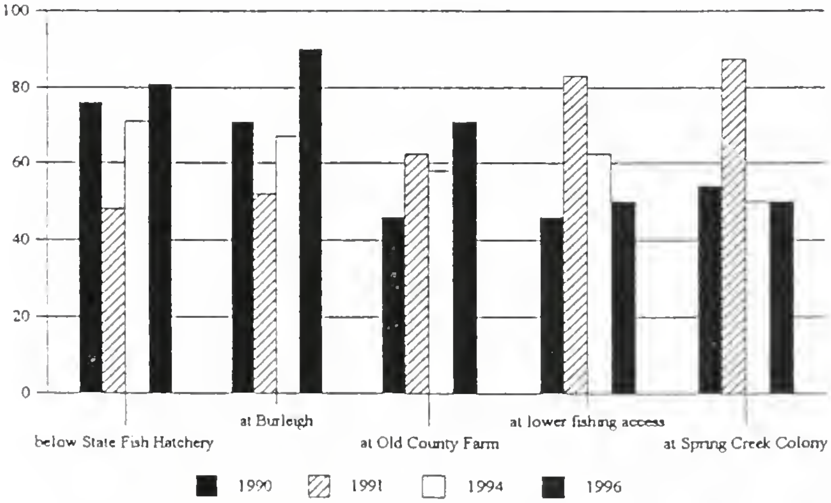
	below State Hatchery	at Burleigh	at Old County Farm	at lower fishing access
at Burleigh	61			
at Old County Farm	13	16		
at lower fishing access	10	23	57	
at Spring Creek Colony	11	15	51	73

Figure 2 illustrates the dramatic change in the macroinvertebrate community between the upper reaches (below the State Fish Hatchery and at Burleigh) which are above Lewistown, and the lower reaches (at the Old County Farm, lower fishing access and at the Spring Creek Colony), below the city. McGuire (1995) attributes the differences to the strong influence of springs and groundwater in the upper reaches, which diminishes with distance downstream. Two distinct internal references and scoring criteria were used to evaluate sites in these two reaches of Big Spring Creek.

Figure 3 compares total bioassessment scores for each site across all years' data. Bioassessment scores from 1990, 1991 and 1994 were recalculated based on updated reference values (Tables 1 and 2). Recalculation resulted in some reclassifications of sites in those years; 1994 classifications are tabulated alongside 1996 classifications in Table 7.

Above Lewistown, biotic integrity generally improved at both sites studied, continuing the trend begun in 1994. Slight impairment was indicated at the site below the State Fish Hatchery, though total bioassessment scores increased 14% there since the 1994 survey. Improvements in taxa richness, EPT richness and the biotic index are mostly accounted for by the addition, since 1994, of the sensitive mayflies *Rhithrogena* sp. and *Paraleptophlebia* sp. and the perlid stonefly *Hesperoperla pacifica.* At Burleigh, an increase in EPT richness and an improvement in the biotic index account for the increase in total

Figure 3. Total bioassessment scores. Big Spring Creek, 1990-1996.



bioassessment score. In general, optimal habitat correlated well with unimpaired biotic integrity at Burleigh.

Below Lewistown, the only site to show improvement in bioassessment scores since 1994 was the site at the Old County Farm; the benthic community indicated slight impairment. Much of the improvement in scores, however, can be attributed to the dominance of a single creature, the intolerant caddisfly *Lepidostoma* sp., which comprises 24% of the community sampled at this site. The other abundant taxa include *Hydropsyche* sp., the mayfly *Baetis tricaudatus* and the midge *Polypedilum* sp., all three of which are tolerant to organic and/or nutrient enrichment. Together, the three comprise another 33% of the sampled community. Moderately high biotic index scores for replicates taken at this site support the suggestion that enrichment impacts the assemblage at Old County Farm.

At the lower fishing access, moderate impairment was indicated, continuing the trend apparent since 1991 toward declining biotic health at this site. Interestingly, this trend was not detected in the 1995 survey; the new reference values for the lower reach of Big Spring Creek generated by the 1996 data have resulted in more stringent criteria. An increase in the biotic index score since 1994 while the perceived habitat quality has improved suggests that organic enrichment continues to limit the biotic health at this site. Tolerant organisms such as *Hydropsyche* sp., *Polypedilum* sp. and the elmid beetle *Optioservus* sp. comprise almost 50% of the sampled communities.

Similarly, water quality impacts the benthic community at the Spring Creek Colony. Moderate impairment was indicated here, with the highest mean biotic index score of any site, suggesting an assemblage tolerant to organic and/or nutrient enrichment. Filter-feeding organisms make up 38% of the macroinvertebrates in the samples from this site, supporting the suggestion.

Figure 4. Habitat scores vs. bioassessment scores. Big Spring Creek, 1990-1996.

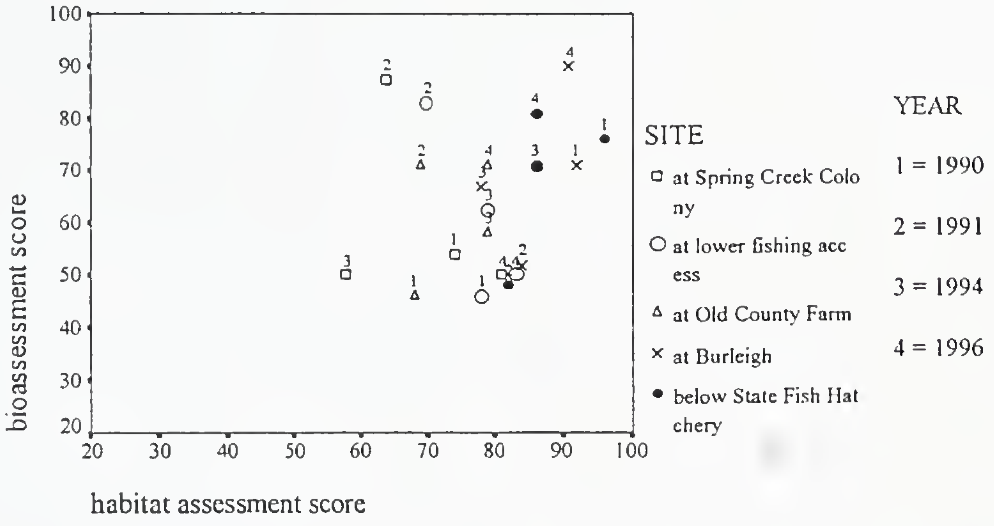


Figure 4 shows the relationship between the total habitat scores and total bioassessment scores for all five sites in all four years studied. Years are represented by the numbers 1 through 4, and sites are distinguished by different symbols on the graph. Points falling in the upper right of the graph (for example, the sites at Burleigh and below the State Fish Hatchery in 1996) illustrate the expected relationship between habitat and biotic scores in situations where habitat conditions are generally good and water quality is not impaired. Bioassessment scores are high; communities have balanced representations of the various functional feeding groups, are diverse, with high proportional abundances of mayflies, stoneflies and caddisflies, and exhibit high sensitivity to pollution.

The relationship between habitat and biotic scores in situations where water quality impairment is impacting biointegrity is illustrated by the cluster of points in the lower right of the graph, representing the lower fishing access in 1990, the site at Burleigh in 1991 and the sites at Spring Creek Colony and the lower fishing access in 1996. Habitat condition scores are not extremely poor, yet bioassessment scores are lower than expected. The communities here are pollution-tolerant and less diverse.

CONCLUSIONS

- Habitat assessments continue to indicate optimal or sub-optimal conditions throughout Big Spring Creek. Improvement in perceived riparian width was noted at all sites evaluated in 1996.

- Distinct benthic communities in the upper (above Lewistown) and lower (below Lewistown) reaches were demonstrated by comparing community similarities between sites. Separate internal references and scoring criteria were used to evaluate sites in each of these reaches.

- Optimal habitat and unimpaired or only slightly impaired benthic communities characterize the upper reaches of Big Spring Creek above Lewistown.

- Sub-optimal habitat and slightly impaired biotic health were indicated at the Old County Farm. Mild organic and/or nutrient enrichment is suggested by the moderately high biotic index score.

- Water quality limits biotic health at the lower fishing access and at the Spring Creek Colony; optimal habitat conditions are coupled with an assemblage tolerant of organic and/or nutrient pollution at these two sites.

TABLES

Table 1. **Internal reference values for Big Spring Creek above Lewistown and criteria for assigning scores to metrics based on percent comparability to reference values (adapted from McGuire 1995):**

metric	Big Spring Creek above Lewistown Reference 1996	Scoring Criteria				
		3	2	1	0	*
Taxa richness	29	> 80%	80-60%	60-40%	< 40%	a
EPT richness	14	> 85%	85-70%	70-55%	< 55%	a
Biotic index	1.37	> 80%	80-60%	60-40%	< 40%	b
% dominant taxon	22	> 70%	70-55%	55-40%	< 40%	b
%Collector (g+ff)	14	> 40%	40-25%	25-10%	< 10%	b
% Scraper +Shredder	94	> 50%	50-40%	40-30%	< 30%	a
% EPT	95	> 75%	75-50%	50-25%	< 25%	a

[1] 1996 Internal reference values are the "best" appropriate values among those calculated in four years of data from sites on Big Spring Creek above Lewistown.

* a = score is ratio of study site to reference x 100.

* b = score is ratio of reference to study site x 100.

Table 2. **Internal reference values for Big Spring Creek below Lewistown and criteria for assigning scores to metrics based on percent comparability to reference values (adapted from McGuire 1995):**

metric	Big Spring Creek below Lewistown Reference 1996	Scoring Criteria				
		3	2	1	0	*
Taxa richness	29	> 80%	80-60%	60-40%	< 40%	a
EPT richness	13	> 85%	85-70%	70-55%	< 55%	a
Biotic index	3.28	> 85%	85-70%	70-50%	< 50%	b
% dominant taxon	17	> 70%	70-55%	55-40%	< 40%	b
%Collector (g+ff)	41	> 80%	80-65%	65-50%	< 50%	b
% Scraper +Shredder	53	> 80%	80-60%	60-40%	< 40%	a
% EPT	81	> 75%	75-50%	50-25%	< 25%	a
%Hydropsych of Trichop.	n.a.	< 50%	50-70%	70-90%	> 90%	c

[1.] 1996 Internal reference values are the "best" appropriate values among those calculated in four years of data from sites on Big Spring Creek below Lewistown.

* a = score is ratio of study site to reference x 100.

* b = score is ratio of reference to study site x 100.

* c = score is based on the actual value, not a percentage of reference.

Table 3a. Criteria for the assignment of support classifications / standards violation thresholds (from Bukantis, 1997)

% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table 3b. Criteria for the assignment of impairment classifications (from Plafkin et al. 1989).

% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

Table 4. Mean metric values, percentage of reference, and bioassessments for Big Spring Creek, August 27, 1996.

metric	below State Fish Hatchery	at Burleigh access	at Old County Farm	at lower fishing access	at Spring Creek Colony
Taxa richness	22.5	24	29	26.5	25.5
EPT richness	12	13	9	9	10
Biotic index	1.63	1.43	4.05	4.52	4.60
% dominant taxon	44	48.5	24	24.5	31.5
% Collector (g+ff)	36.5	29	64	77	80
% Scrapers + Shredders	60	63.5	30.5	11	10
% EPT	77	76	59.5	53.5	57.5
% Hydropsychinae of Trichoptera	-	-	42.5	70.5	74
% of reference	upper reference	upper reference	lower reference	lower reference	lower reference
Taxa richness	78	83	100	91	88
EPT richness	86	93	69	69	77
Biotic index	84	96	81	73	71
% dominant taxon	50	45	71	69	54
% Collector (g+ff)	38	48	64	53	51
% Scrapers + Shredders	64	68	58	21	19
% EPT	81	80	73	66	71
% Hydropsychinae of Trichoptera	-	-	n.a.	n.a.	n.a.
metric score					
Taxa richness	2	3	3	3	3
EPT richness	3	3	2	1	2
Biotic index	3	3	2	2	2
% dominant taxon	1	1	3	2	1
% Collector (g+ff)	2	3	1	1	1
% Scrapers + Shredders	3	3	1	0	0
% EPT	3	3	2	2	2
% Hydropsychinae of Trichoptera	-	-	3	1	1
total score	17	19	17	12	12
% reference	81	90	71	50	50
classification *	SLI	NON	SLI	MOD	MOD
use support	FULL SUPPORT	FULL SUPPORT	PART.SUPPORT	PART.SUPPORT	PART.SUPPORT

* classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired..

Table 5. Stream and riparian habitat assessment: Big Spring Creek, August 27, 1996.

Max. possible score	Location:	below State Fish Hatchery *	at Burleigh access	at Old County Farm	at lower fishing access (Hruska)	at Spring Creek Colony
	Parameter					
10	riffle development		8	9	8	9
10	substrate development		9	9	8	9
20	embeddedness		20	14	13	16
20	channel alteration		18	15	15	18
20	sediment deposition		18	14	15	20
20	flow status		20	19	20	20
10/10	bank stability (right/left)		10 / 10	8 / 9	8 / 8	9 / 5
10/10	bank vegetative cover (right/left)		9 / 8	9 / 5	10 / 10	10 / 4
10/10	riparian width (right/left)		8 / 8	10 / 2	9 / 9	6 / 2
160	TOTAL:		146	123	133	128
	PERCENT OF MAXIMUM:		91	77	83	80
	CONDITION[1]:		OPTIMAL	SUB-OPTIMAL	OPTIMAL	OPTIMAL

1. Condition categories: Optimal > 81% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%.

* no data available for 1996.

Table 6. Trends in habitat condition.Big Spring Creek, 1990-1996.

	below State Fish Hatchery				at Burleigh access				at Old County Farm				at lower fishing access				at Spring Creek Colony			
YEAR	90	91	94	96*	90	91	94	96	90	91	94	96	90	91	94	96	90	91	94	96
substrate *	19	20	17		19	11	16	18	11	15	18	18	15	16	14	16	16	18	16	18
embeddedness *	15	16	20		18	10	16	20	12	10	15	14	16	6	16	13	16	12	18	16
discharge/vel. depth	20	16	13		20	20	13		16	19	20		16	15	14		18	17	17	
channel alteration *	20	20	13		19	19	16	18	12	19	15	16	13	20	20	15	12	17	20	18
pool/riffle ratio	20	16	16		20	20	15		16	20			17	15	12		16	16	9	
flow status								20			19	19				20				20
bank stability *	20	18	18		14	20	20	20	14	16	20	17	18	16	20	16	14	4	8	14
bank vegetation *	20	18	20		18	18	20	17	18	18	20	14	18	18	20	20	16	12	8	14
riparian width		4	14			16	4	15		4	4	12		10	4	18		6	0	8
sediment deposition	20	16	20		19	15	16	18	12	19	20	14	13	19	17	15	12	20	11	20
riffle development								16				18				16				18
canopy cover		15				16				5				5				10		
streamside cover	20	18	20		18	20	20		12	10	6		14	10	20		14	10	8	
grazing pressure		20				16				10				18				12		
* Total: 6 parameters common to all assessments (120 max score)	114	108	108		107	93	104	111	79	97	108	93	93	95	107	95	86	83	81	100
percent of max score	95	90	90		89	78	87	93	66	81	90	78	78	79	89	79	72	69	68	83
classification ¹	opt	opt	opt		opt	sub	opt	opt	sub	opt	opt	sub	sub	sub	opt	sub	sub	sub	sub	opt
Total: All scored parameters	173	197	171		165	201	156	163	123	165	157	142	140	168	157	149	134	154	115	146
Max. possible score	180	240	200	180	180	240	200	180	180	240	200	180	180	240	200	180	180	240	200	180
percent of max score	96	82	86		92	84	78	91	68	69	79	79	78	70	79	83	74	64	58	81
classification ¹	**opt**	**opt**	**opt**		**opt**	**opt**	**sub**	**opt**	**sub**	**sub**	**sub**	**sub**	**sub**	**sub**	**sub**	**opt**	**sub**	**sub**	**sub**	**opt**

¹For criteria see note for Table 4. * No habitat data available for this site in 1996.

Table 7. Trends in mean bioassessment metric scores. Big Spring Creek, 1990-1996.

	below State Fish Hatchery				at Hurleigh access				at Old County Farm				at lower fishing access				at Spring Creek Colony			
YEAR	90	91	94	96	90	91	94	96	90	91	94	96	90	91	94	96	90	91*	94	96
# of taxa	18.5	26	18.5	22.5	19.5	22.5	23.5	24	22.5	24	25.5	29	28	25.5	23	26.5	25.5	21	25.5	25.5
EPT richness	9	9.5	9.5	12	9.5	8.5	11.5	13	7.5	9.5	9	9	8	8	11	9	11.5	13	11	10
Biotic index	1.51	3.69	1.95	1.63	1.75	3.78	2.97	1.43	4.84	3.33	4.70	4.05	4.90	4.33	4.24	4.52	4.34	3.64	4.54	4.60
% dominant	51.5	28	45	44	42	23	24	48.5	25.5	27	38	24	40	28.5	29	24.5	43.5	32	40.5	31.5
% collectors	5	67.5	27	36.5	9	52	55	29	71.5	71	81	64	78	43	65	77	87	51	84	80
% scrape +shred	93.5	23.5	71	60	90	41.5	42	63.5	9.5	17	12	30.5	10.5	51.5	20	11	5.5	46	6.5	10
%Hydro.of Trich.	-	-	-	-	-	-	-	-	77.5	60	26	42.5	72.5	15	29	70.5	69	32	88	74
% EPT	94.5	60	83	77	91	46.5	62	76	40	63.5	58	59.5	62	70.5	73	53.5	80.5	92	72	57.5
metric score as percent of 1996 reference	76	48	71	81	71	52	67	90	46	62.5	58	71	46	83	62.5	50	54	87.5	50	50
Classification based on 1996 internal reference	sli	mod	sli	sli	sli	sli-mod	sli	non	mod	sli	sli	sli	mod	non	sli	mod	sli	non	mod	mod
Classification based on 1994 reference	sli	mod	sli		sli	mod	sli		mod	sli	sli		sli	sli	sli		sli	non	sli	
Use support category based on 1996 reference	full	part	part	full	part	part	part	full	part	part	part	part	part	full	part	part	part	full	part	part

* Based on a single sample.

APPENDIX A

Aquatic Macroinvertebrate Taxa and Metric Data

BIG SPRING CREEK

August 27, 1996

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

Below State Fish Hatchery	1.1		1.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
Nais	0	0	1	0.40	8	CG
Lymnaeidae	1	0.29	11	4.44	6	SC
TOTAL: MISC. TAXA	1	0.29	12	4.84		
Baetis tricaudatus	1	0.29	2	0.81	4	CG
Diphetor hageni	0	0	1	0.40	5	CG
Ephemerella	22	6.43	25	10.08	2	SC
Rhithrogena	3	0.88	5	2.02	0	SC
Paraleptophlebia	0	0	2	0.81	1	CG
TOTAL: EPHEMEROPTERA	26	7.60	35	14.11		
Amphinemura	5	1.46	10	4.03	2	SH
Hesperoperla pacifica	1	0.29	1	0.40	1	PR
Isoperla	1	0.29	1	0.40	2	PR
TOTAL: PLECOPTERA	7	2.05	12	4.84		
Brachycentrus	47	13.74	41	16.53	1	CF
Micrasema	1	0.29	2	0.81	1	SH
Glossosoma	223	65.20	56	22.58	0	SC
Hydropsyche	0	0	1	0.40	5	CF
Lepidostoma	4	1.17	0	0	1	
SHRhyacophila Brunnea Gr.	8	2.34	6	2.42	2	PR
TOTAL: TRICHOPTERA	283	82.75	106	42.74		
Heterlimnius	6	1.75	12	4.84	3	CG
Optioservus	4	1.17	8	3.23	5	CG
TOTAL: COLEOPTERA	10	2.92	20	8.06		
Simulium	0	0	50	20.16	5	CF
Antocha	1	0.29	1	0.40	3	CG
Dicranota	1	0.29	0	0	3	PR
TOTAL: DIPTERA	2	0.58	51	20.56		
Chironomidae-pupae	1	0.29	0	0	6	UN
Brillia	0	0	1	0.40	4	SH
Eukiefferiella	5	1.46	5	2.02	8	CG
Orthocladius	1	0.29	0	0	6	CG
Pagastia	1	0.29	1	0.40	1	CG
Parametriocnemus	0	0	1	0.40	5	CG
Rheotanytarsus	1	1.29	0	0	6	CF
Tvetenia	4	1.17	4	1.61	5	CG
TOTAL: CHIRONOMIDAE	13	3.80	12	4.84		
GRAND TOTAL	342	100.00	248	100.00		

1 Functional feeding group designations are given in TABLE A.
2 Biotic index scores for individual taxa, as given in Bukantis, 1997

Aquatic Macroinvertebrate Data: Big Spring Creek: below State Fish Hatchery

Sample:	1.1	1.2
% of sample used:	14.6	14.6
Subsample size	342	248
Taxa richness	21	24
EPT richness	11	13
Biotic index	.75	2.50
% Dominant taxon	65	23
% EPT	92	62
% Collectors (g+f)	21	52
% Scrapers + Shredders	76	44
% Hydropsychinae of Trich	0	.4
Metals tolerance index	2.45	3.35
Shannon Diversity (log2)	2.01	3.38
EPT/Chironomidae	24.31	12.75
CTQa	59.50	65.79
%Baetidae of Ephemeroptera	4	9
% Coleoptera	3	8
% Diptera	<1	21
% Chironomidae	4	5
% Ephemeroptera	8	14
% Plecoptera	2	5
% Trichoptera	83	43
% multivoltine	3	5
% univoltine	79	69
% semivoltine	18	26

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	14	2	37	3
Collector-Gatherers	7	8	15	11
Shredders	3	3	5	3
Scrapers	73	4	39	4
Predators	3	4	3	3

Est. total number of organisms	2345	1701
Est. number collected per foot	78	57
Est. number collected per minute	2345	1701

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

Burleigh Access	2.1		2.2			
Taxon	#	%	#	%	BI	FFG
Nais	0	0	1	0.39	8	CG
Acari	1	0.36	0	0	5	PA
TOTAL: MISC. TAXA	1	0.36	1	0.39		
Acentrella	1	0.36	2	0.78	4	CG
Baetis tricaudatus	2	0.72	4	1.56	4	CG
Drunella doddsi	1	0.36	0	0	1	SC
Ephemerella	10	3.62	4	1.56	2	SC
Rhithrogena	22	7.97	25	9.77	0	SC
Leptophlebiidae	0	0	1	0.39	2	CG
TOTAL: EPHEMEROPTERA	36	13.04	36	14.06		
Capniidae	1	0.36	0	0	1	SH
Hesperoperla pacifica	0	0	7	2.73	1	PR
Perlodidae	1	0.36	0	0	2	PR
Isoperla	2	0.72	0	0	2	PR
TOTAL: PLECOPTERA	4	1.45	7	2.73		
Trichoptera	0	0	1	0.39	11	UN
Brachycentrus	16	5.80	9	3.52	1	CF
Glossosoma	144	52.17	116	45.31	0	SC
Parapsyche	1	0.36	0	0	0	CF
Lepidostoma	11	3.99	4	1.56	1	SH
Apatania	1	0.36	0	0	3	SC
Wormaldia	0	0	1	0.39	0	CF
Rhyacophila Brunnea Gr.	4	1.45	14	5.47	2	PR
TOTAL: TRICHOPTERA	177	64.13	145	56.64		
Optioservus	36	13.04	32	12.50	5	CG
TOTAL: COLEOPTERA	36	13.04	32	12.50		
Atherix	1	0.36	1	0.39	5	PR
Chelifera	5	1.81	0	0	5	PR
Simulium	1	0.36	6	2.34	5	CF
Antocha	0	0	10	3.91	3	CG
Hexatoma	0	0	1	0.39	2	PR
TOTAL: DIPTERA	7	2.54	18	7.03		
Chironomidae-pupae	1	0.36	1	0.39	6	UN
Micropsectra	2	0.72	4	1.56	4	CG
Orthocladius	0	0	2	0.78	6	CG
Pagastia	0	0	5	1.95	1	CG
Parametriocnemus	4	1.45	2	0.78	5	CG
Polypedilum	1	0.36	0	0	6	CG
Thienemanniella	4	1.45	0	0	6	CG
Thienemannimyia	1	0.36	0	0	6	CG
Tvetenia	2	0.72	3	1.17	5	CG
TOTAL: CHIRONOMIDAE	15	5.43	17	6.64		
GRAND TOTAL	276	100.00	256	100.00		

Aquatic Macroinvertebrate Data: Big Spring Creek: Burleigh Access

Sample:	2.1	2.2
% of sample used:	10.4	12.5
Subsample size	276	256
Taxa richness	25	23
EPT richness	14	12
Biotic index	1.37	1.49
% Dominant taxon	52	45
% EPT	79	73
% Collectors (g+f)	26	32
% Scrapers + Shredders	69	58
% Hydropsychinae of Trich	0	0
Metals tolerance index	2.61	2.79
Shannon Diversity (log2)	2.69	3.01
EPT/Chironomidae	14.47	11.06
CTQa	68.08	62.04
%Baetidae of Ephemeroptera	8	17
% Coleoptera	13	13
% Diptera	3	7
% Chironomidae	5	7
% Ephemeroptera	13	14
% Plecoptera	1	3
% Trichoptera	64	57
% multivoltine	5	7
% univoltine	75	72
% semivoltine	20	22

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	7	3	6	3
Collector-Gatherers	19	9	26	11
Shredders	4	2	2	1
Scrapers	64	5	57	3
Predators	5	5	9	4

Est. total number of organisms	2650	2048
Est. number collected per foot	74	57
Est. number collected per minute	2741	2048

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK: at County Farm	3.1		3.2			
Taxon	#	%	#	%	BI	FFG
Hydra	0	0	2	2	8	PR
Turbellaria	7	1.92	0	0	4	PR
Nais	15	4.12	15	4.11	8	CG
Ophidonais	3	0.82	1	0.27	6	CG
Tubificidae	0	0	2	0.55	10	CG
Physidae	18	4.95	6	1.64	8	CG
Gammarus	0	0	2	0.55	4	CG
Caecidotea	0	0	1	0.27	8	CG
Acari	1	0.27	12	3.29	5	SC
TOTAL: MISC. TAXA	44	12.09	41	11.23		
Acentrella	1	0.27	0	0	4	CG
Baetis tricaudatus	36	9.89	37	10.14	4	CG
Ephemerella	16	4.40	5	1.37	2	SC
Tricorythodes	5	1.37	3	0.82	4	CG
TOTAL: EPHEMEROPTERA	58	15.93	45	12.33		
Skwala	3	0.82	1	0.27	3	PR
TOTAL: PLECOPTERA	3	0.82	1	0.27		
Amiocentrus aspilus	0	0	1	0.27	3	CG
Brachycentrus	7	1.92	3	0.82	1	CF
Helicopsyche	0	0	1	0.27	3	SC
Cheumatopsyche	13	3.57	0	0	5	CF
Hydropsyche	58	15.93	66	18.08	5	CF
Lepidostoma	73	20.05	104	28.49	1	SH
TOTAL: TRICHOPTERA	151	41.48	175	47.95		
Heterlimnius	7	1.92	0	0	3	CG
Optioservus	10	2.75	10	2.74	5	CG
TOTAL: COLEOPTERA	17	4.67	10	2.74		
Chelifera	1	0.27	0	0	5	PR
Limnophora	0	0	1	0.27	6	PR
Simulium	2	0.55	3	0.82	5	CF
Tipulidae	1	0.27	0	0	3	UN
Antocha	1	0.27	3	0.82	3	CG
Hexatoma	3	0.82	0	0	2	PR
TOTAL: DIPTERA	8	2.20	7	1.92		
Chironomidae-pupae	3	0.82	2	0.55	6	UN
Cricotopus Trifascia Gr.	2	0.55	0	0	6	CG
Eukiefferiella	5	1.37	4	1.10	8	CG
Orthocladiinae	3	0.82	6	1.64	6	CG
Orthocladius	9	2.47	9	2.47	6	CG
Pagastia	5	1.37	0	0	1	CG
Parametriocnemus	15	4.12	21	5.75	5	CG
Polypedilum	20	5.49	22	6.03	6	CG
Rheocricotopus	18	4.95	6	1.64	4	CG
Rheotanytarsus	0	0	4	1.10	6	CF
Stichtochironomus	0	0	2	0.55	5	CG
Tanytarsus	0	0	2	0.55	6	CF
Tvetenia	3	0.82	8	2.19	5	CG
TOTAL: CHIRONOMIDAE	83	22.80	86	23.56		
GRAND TOTAL	364	100.00	365	100.00		

Aquatic Macroinvertebrate Data: Big Spring Creek: at County Farm

Sample:	3.1	3.2
% of sample used:	10.4	16.7
Subsample size	364	365
Taxa richness	29	29
EPT richness	9	9
Biotic index	4.08	4.01
% Dominant taxon	20	28
% EPT	58	61
% Collectors (g+f)	65	63
% Scrapers + Shredders	29	32
% Hydropsychinae of Trich	47	38
Metals tolerance index	3.70	3.48
Shannon Diversity (log2)	4.02	3.66
EPT/Chironomidae	2.55	2.57
CTQa	88.35	88.56
%Baetidae of Ephemeroptera	64	82
% Coleoptera	5	3
% Diptera	2	2
% Chironomidae	23	24
% Ephemeroptera	16	12
% Plecoptera	1	<1
% Trichoptera	41	48
% multivoltine	32	33
% univoltine	62	63
% semivoltine	7	4

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	22	4	21	5
Collector-Gatherers	43	17	42	18
Shredders	20	1	28	1
Scrapers	10	2	3	3
Predators	4	4	1	3

Est. total number of organisms	3494	2190
Est. number collected per foot	90	73
Est. number collected per minute	3494	2190

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

at lower fishing access (Hruska)	4.1		4.2			
Taxon	#	%	#	%	BI	FFG
Turbellaria	0	0	3	0.92	4	PR
Nais	4	1.14	2	0.61	8	CG
Pristina	0	0	1	0.31	8	CG
Physidae	1	0.29	3	0.92	8	SC
Caecidotea	0	0	1	0.31	8	CG
Acari	6	1.71	1	0.31	5	PA
TOTAL: MISC. TAXA	11	3.14	11	3.36		
Baetis	29	8.29	0	0	5	CG
Baetis tricaudatus	0	0	50	15.29	4	CG
Ephemerellidae	2	0.57	0	0	1	CG
Ephemerella	0	0	8	2.45	5	SC
Rhithrogena	0	0	2	0.61	0	SC
Tricorythodes	1	0.29	4	1.22	4	CG
TOTAL: EPHEMEROPTERA	32	9.14	64	19.57		
Perlodidae	3	0.86	0	0	2	PR
Skwala	10	2.86	24	7.34	3	PR
TOTAL: PLECOPTERA	13	3.71	24	7.34		
Brachycentrus	1	0.29	2	0.61	1	CF
Helicopsyche	1	0.29	5	1.53	2	SC
Hydropsyche	112	32.00	54	16.51	5	CF
Lepidostoma	26	8.29	25	7.65	1	SH
TOTAL: TRICHOPTERA	143	40.86	86	26.30		
Optioservus	35	10.00	46	14.07	5	CG
TOTAL: COLEOPTERA	35	10.00	46	14.07		
Atherix	1	0.29	0	0	5	PR
Limnophora	1	0.29	0	0	6	PR
Simulium	9	2.57	1	0.31	5	CF
Antocha	2	0.57	0	0	3	CG
Hexatoma	4	1.14	5	1.53	2	PR
TOTAL: DIPTERA	17	4.86	6	1.83		
Chironomidae-pupae	8	2.29	12	3.67	6	UN
Cardiocladius albiplumus	0	0	1	0.31	5	PR
Cryptochironomus	0	0	1	0.31	8	PR
Eukiefferiella	2	0.57	2	0.61	8	CG
Micropsectra	0	0	1	0.31	4	CG
Orthocladiinae	10	2.86	2	0.61	6	CG
Orthocladius	0	0	1	0.31	6	CG
Pagastia	0	0	1	0.31	1	CG
Parametriocnemus	2	0.57	4	1.22	5	CG
Polypedilum	52	14.86	31	9.48	6	CG
Rheocricotopus	14	4.00	27	8.26	4	CG
Rheotanytarsus	2	0.57	0	0	6	CF
Tvetenia	9	2.57	7	2.14	5	CG
TOTAL: CHIRONOMIDAE	99	28.29	90	27.52		
GRAND TOTAL	350	100.00	327	100.00		

Aquatic Macroinvertebrate Data:Big Spring Creek: at Lower Fishing Access (Hruska)

Sample:	4.1	4.2
% of sample used:	10.4	16.7
Subsample size	350	327
Taxa richness	25	28
EPT richness	9	9
Biotic index	4.73	4.30
% Dominant taxon	32	17
% EPT	54	53
% Collectors (g+f)	82	72
% Scrapers + Shredders	9	13
% Hydropsychinae of Trich	78	63
Metals tolerance index	3.97	4.04
Shannon Diversity (log2)	3.40	3.77
EPT/Chironomidae	1.90	1.93
CTQa	79.00	87.57
%Baetidae of Ephemeroptera	91	78
% Coleoptera	10	14
% Diptera	5	2
% Chironomidae	28	28
% Ephemeroptera	9	20
% Plecoptera	4	7
% Trichoptera	41	26
% multivoltine	37	37
% univoltine	53	48
% semivoltine	10	15

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	35	4	17	3
Collector-Gatherers	46	12	55	15
Shredders	8	1	8	1
Scrapers	1	2	6	4
Predators	5	5	10	5

Est. total number of organisms	3360	1962
Est. number collected per foot	120	245
Est. number collected per minute	3360	1962

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK at Spring Creek Colony	5.1		5.2			
Taxon	#	%	#	%	BI	FFG
Nais	1	0.32	1	0.35	8	CG
Pristina	1	0.32	0	0	8	CG
Tubificidae	1	0.32	0	0	10	CG
Physidae	0	0	1	0.35	8	SC
Acari	3	0.97	1	0.35	5	PA
TOTAL: MISC. TAXA	6	1.94	3	1.06		
Baetis tricaudatus	29	9.35	38	13.43	4	CG
Ephemerella	2	0.65	2	0.71	2	SC
Tricorythodes	4	1.29	5	1.77	4	CG
TOTAL: EPHEMEROPTERA	35	11.29	45	15.90		
Perlodidae	2	0.65	0	0	2	PR
Skwala	5	1.61	2	0.71	3	PR
TOTAL: PLECOPTERA	7	2.26	2	0.71		
Brachycentrus	4	1.29	4	1.41	1	CF
Micrasema	1	0.32	0	0	1	SH
Helicopsyche	4	1.29	7	2.47	3	SC
Hydropsyche	71	22.90	114	40.28	5	CF
Hydroptilidae	3	0.97	1	0.35	4	PH
Lepidostoma	17	5.48	23	8.13	1	SH
TOTAL: TRICHOPTERA	100	32.26	149	52.65		
Dytiscidae	0	0	1	0.35	5	PR
Optioservus	15	4.84	8	2.83	5	CG
TOTAL: COLEOPTERA	15	4.84	9	3.18		
Atherix	16	5.16	1	0.35	5	PR
Simulium	12	3.87	9	3.18	5	CF
Hexatoma	11	3.55	0	0	2	PR
TOTAL: DIPTERA	39	12.58	10	3.53		
Chironomidae-pupae	11	3.55	6	2.12	6	UN
Cladotanytarsus	1	0.32	0	0	7	CG
Cricotopus Trifascia Gr.	0	0	1	0.35	6	CG
Eukiefferiella	1	0.32	0	0	8	CG
Microtendipes	2	0.65	0	0	6	CG
Orthocladiinae	2	0.65	3	1.06	6	CG
Orthocladius	4	1.29	0	0	6	CG
Pagastia	1	0.32	2	0.71	1	CG
Polypedilum	56	18.06	38	13.43	6	CG
Rheocricotopus	17	5.48	6	2.12	4	CG
Rheotanytarsus	4	1.29	9	3.18	6	CF
Stictochironomus	1	0.32	0	0	5	CG
Thienemannimyia	1	0.32	0	0	6	CG
Tvetenia	7	2.26	0	0	5	CG
TOTAL: CHIRONOMIDAE	108	34.84	65	22.97		
GRAND TOTAL	310	100.00	283	100.00		

Aquatic Macroinvertebrate Data: Big Spring Creek: at Spring Creek Colony

Sample:	5.1	5.2
% of sample used:	10.4	10.4
Subsample size	310	283
Taxa richness	29	22
EPT richness	11	9
Biotic index	4.64	4.55
% Dominant taxon	23	40
% EPT	46	69
% Collectors (g+f)	76	84
% Scrapers + Shredders	8	12
% Hydropsychinae of Trich	71	77
Metals tolerance index	3.99	3.35
Shannon Diversity (log2)	3.85	3.04
EPT/Chironomidae	1.31	3.02
CTQa	84.44	83.04
%Baetidae of Ephemeroptera	83	84
% Coleoptera	5	3
% Diptera	13	4
% Chironomidae	35	23
% Ephemeroptera	11	16
% Plecoptera	2	1
% Trichoptera	32	53
% multivoltine	41	38
% univoltine	53	57
% semivoltine	6	5

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	29	4	48	4
Collector-Gatherers	46	17	36	9
Shredders	6	2	8	1
Scrapers	2	2	4	3
Predators	11	4	1	3

Est. total number of organisms	2976	2717
Est. number collected per foot	83	97
Est. number collected per minute	2976	2717

TABLE A. Functional Feeding Groups

Abbreviation	Description
CF	Collector - filterer
CG	Collector - gatherer
OM	Omnivore
PA	Parasite
PR	Predator
SC	Scraper
UN	Unknown
SH	Shredder

APPENDIX B

Aquatic Macroinvertebrate Taxa and Metric Data

BIG SPRING CREEK

July 26, 1990

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

below State Fish Hatchery: 7/25/90	1.1		1.2			
Taxon	#	%	#	%	BI	FFG
Turbellaria	3	1.01	2	0.67	4	PR
Oligochaeta	1	0.34	0	0	10	CG
Sphaerium	1	0.34	1	0.33	8	CF
Fossaria	1	0.34	1	0.33	6	SC
Physella	3	1.01	0	0	8	SC
TOTAL: MISC. TAXA	9	3.02	4	1.33		
Acentrella	3	1.01	1	0.33	4	CG
Baetis tricaudatus	4	1.34	3	1.00	4	CG
Diphetor hageni	1	0.34	0	0	5	CG
Ephemerella inermis	17	5.70	22	7.33	4	SC
TOTAL: EPHEMEROPTERA	25	8.39	26	8.67		
Malenka	2	0.67	3	1.00	1	SH
TOTAL: PLECOPTERA	2	0.67	3	1.00		
Brachycentrus americanus	73	24.50	78	26.00	1	SC
Micrasema	20	6.71	19	6.33	1	SH
Glossosoma	6	2.01	2	0.67	0	SC
Lepidostoma-sand case larvae	153	51.34	155	51.67	1	SH
Rhyacophila Brunnea Gr.	3	1.01	0	0	2	PR
TOTAL: TRICHOPTERA	255	85.57	254	84.67		
Optioservus	0	0	1	0.33	5	SC
TOTAL: COLEOPTERA	0	0	1	0.33		
Prosimulium	2	0.67	1	0.33	4	CF
Simulium	0	0	1	0.34	5	CF
Antocha	2	0.67	2	0.67	3	CG
Tipula	1	0.34	1	0.33	4	SH
TOTAL: DIPTERA	6	2.01	4	1.33		
Cladotanytarsus	0	0	7	2.33	7	CG
Orthocladius	1	0.34	0	0	6	CG
Thienemanniella	0	0	1	0.33	6	CG
TOTAL: CHIRONOMIDAE	1	0.34	8	2.67		
GRAND TOTAL	298	100.00	300	100.00		

Aquatic Macroinvertebrate Data:Big Spring Creek at State Fish Hatchery: 7/26/90

Sample:	1.1	1.2
% of sample used:	5	5
Subsample size	298	300
Taxa richness	20	17
EPT richness	10	8
Biotic index	1.49	1.52
% Dominant taxon	51	52
% EPT	95	94
% Collectors (g+f)	9	5
% Scrapers + Shredders	93	94
% Hydropsychinae of Trich	0	0
Metals tolerance index	2.16	2.18
Shannon Diversity (log2)	2.29	2.12
EPT/Chironomidae	282.00	35.38
CTQa	66.60	66.47
%Baetidae of Ephemeroptera	32	15
% Coleoptera	0	<1
% Diptera	2	1
% Chironomidae	<1	3
% Ephemeroptera	8	9
% Plecoptera	1	1
% Trichoptera	86	85
% multivoltine	3	4
% univoltine	71	70
% semivoltine	25	26

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	1	3	1	2
Collector-Gatherers	4	6	5	5
Shredders	59	4	59	4
Scrapers	34	5	35	5
Predators	2	2	1	1

Est. total number of organisms	5456	5456
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

at Burleigh 7/26/90	2.1		2.2			
Taxon	#	%	#	%	BI	FFG
Turbellaria	1	0.33	0	0	4	PR
Oligochaeta	4	1.33	6	2.00	10	CG
Physella	1	0.33	1	0.33	8	SC
TOTAL: MISC. TAXA	6	2.00	7	2.33		
Acentrella	6	2.00	3	1.00	4	CG
Baetis tricaudatus	2	0.67	1	0.33	4	CG
Diphetor hageni	2	0.67	2	0.67	5	CG
Ephemerella inermis	25	8.33	22	7.33	4	SC
Heptageniidae	1	0.33	4	SC		
Rhithrogena	0	0	1	0.33	0	SC
TOTAL: EPHEMEROPTERA	36	12.00	29	9.67		
Hesperoperla pacifica	0	0	1	0.33	1	PR
TOTAL: PLECOPTERA	0	0	1	0.33		
Brachycentrus americanus	118	39.33	103	34.33	1	SC
Micrasema	2	0.67	3	1.00	1	SH
Glossosoma	0	0	3	1.00	0	SC
Hydropsyche	2	0.67	0	0	5	CF
Lepidostoma-sand case larvae	119	39.67	131	43.67	1	SH
TOTAL: TRICHOPTERA	241	80.33	240	80.00		
Optioservus	5	1.67	5	1.67	5	SC
TOTAL: COLEOPTERA	5	1.67	5	1.67		
Simuliidae	2	0.67	1	0.33	6	CF
Antocha	6	2.00	8	2.67	3	CG
TOTAL: DIPTERA	8	2.67	9	3.00		
Cladotanytarsus	1	0.33	4	1.33	7	CG
Eukiefferiella	1	0.33	0	0	8	CG
Nanocladius	0	0	1	0.33	3	CG
Pagastia	0	0	1	0.33	1	CG
Sublettea	0	0	2	0.67	4	UN
Thienemanniella	1	0.33	1	0.33	6	CG
Tvetenia	1	0.33	0	0	5	CG
TOTAL: CHIRONOMIDAE	4	1.33	9	3.00		
GRAND TOTAL	300	100.00	300	100.00		

Aquatic Macroinvertebrate Data:Big Spring Creek at Burleigh 7/26/90

Sample:	2.1	2.2
% of sample used:	9	9
Subsample size	300	300
Taxa richness	19	20
EPT richness	9	10
Biotic index	1.76	1.74
% Dominant taxon	40	44
% EPT	92	90
% Collectors (g+f)	9	9
% Scrapers + Shredders	90	90
% Hydropsychinae of Trich	0	0
Metals tolerance index	2.60	2.52
Shannon Diversity (log2)	2.20	2.28
EPT/Chironomidae	69.25	30.00
CTQa	77.79	69.25
%Baetidae of Ephemeroptera	28	21
% Coleoptera	2	2
% Diptera	3	3
% Chironomidae	1	3
% Ephemeroptera	12	10
% Plecoptera	0	<1
% Trichoptera	80	80
% multivoltine	4	4
% univoltine	54	59
% semivoltine	42	37

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	1	2	<1	1
Collector-Gatherers	8	9	9	9
Shredders	40	2	45	2
Scrapers	50	5	45	6
Predators	<1	1	<1	1

Est. total number of organisms	3364	3364
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

at Old County Farm 7/26/90	3.1		3.2			
Taxon	#	%	#	%	BI	FFG
Turbellaria	34	11.33	43	14.33	4	PR
Nematoda	2	0.67	0	0	5	OM
Physella	2	0.67	3	1.00	8	SC
TOTAL: MISC. TAXA	38	12.67	46	15.33		
Acentrella	14	4.67	10	3.33	4	CG
Baetis tricaudatus	76	25.33	78	26.00	4	CG
Ephemerella inermis	4	1.33	4	1.33	4	SC
Rhithrogena	1	0.33	2	0.67	0	SC
Tricorythodes minutus	19	6.33	20	6.67	4	CG
TOTAL: EPHEMEROPTERA	114	38.00	114	38.00		
Perlodidae	1	0.33	0	0	2	PR
TOTAL: PLECOPTERA	1	0.33	0	0		
Amiocentrus aspilus	1	0.33	0	0	3	CG
Brachycentrus americanus	0	0	1	0.33	1	SC
Hydropsyche	3	1.00	4	1.33	5	CF
TOTAL: TRICHOPTERA	4	1.33	5	1.67		
Optioservus	27	9.00	13	4.33	5	SC
TOTAL: COLEOPTERA	27	9.00	13	4.33		
Ceratopogonidae	1	0.33	0	0	6	PR
Simuliidae	11	3.67	13	4.33	6	CF
Antocha	1	0.33	0	0	3	CG
Hexatoma	6	2.00	8	2.67	2	PR
TOTAL: DIPTERA	19	6.33	21	7.00		
Chironomidae-pupae	3	1.00	3	1.00	6	UN
Cardiocladius	1	0.33	1	0.33	5	PR
Conchapelopia/Thienemannimyia	0	0	1	0.33	6	PR
Cricotopus	0	0	1	0.33	7	CG
Eukiefferiella	14	4.67	26	8.67	8	CG
Orthocladius	56	18.67	47	15.67	6	CG
Parametriocnemus	2	0.67	4	1.33	5	CG
Polypedilum	14	4.67	10	3.33	6	CG
Potthastia	1	0.33	4	1.33	2	CG
Sublettea	5	1.67	4	1.33	4	UN
Tanytarsus	1	0.33	0	0	6	CF
TOTAL: CHIRONOMIDAE	97	32.33	101	33.67		
GRAND TOTAL	300	100.00	300	100.00		

Aquatic Macroinvertebrate Data: Big Spring Creek at Old County Farm 7/26/90

Sample:	3.1	3.2
% of sample used:	14	14
Subsample size	300	300
Taxa richness	24	21
EPT richness	8	7
Biotic index	4.83	4.85
% Dominant taxon	25	26
% EPT	40	40
% Collectors (g+f)	71	72
% Scrapers + Shredders	11	8
% Hydropsychinae of Trich	75	80
Metals tolerance index	4.73	4.25
Shannon Diversity (log2)	3.46	3.46
EPT/Chironomidae	1.23	1.18
CTQa	87.08	90.77
%Baetidae of Ephemeroptera	79	77
% Coleoptera	9	4
% Diptera	6	7
% Chironomidae	32	34
% Ephemeroptera	38	38
% Plecoptera	<1	0
% Trichoptera	1	2
% multivoltine	59	62
% univoltine	32	33
% semivoltine	9	5

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	5	3	6	2
Collector-Gatherers	66	10	67	9
Shredders	0	0	0	0
Scrapers	11	4	8	5
Predators	14	5	18	4

Est. total number of organisms	2196	2196
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown

Macroinvertebrate Taxonomic Data

BIG SPRING CREEK:

at lower fishing access 7/26/90	4.1		4.2			
Taxon	#	%	#	%	BI	FFG
Turbellaria	19	6.33	18	6.19	4	PR
Nematoda	2	0.67	2	0.69	5	OM
Oligochaeta	6	2.00	2	0.69	10	CG
Hirudinea	2	0.67	0	0	8	PR
Sphaeriidae	1	0.33	2	0.69	8	CF
Physella	15	5.00	10	3.44	8	SC
Caecidotea	9	3.00	11	3.78	8	CG
Acari	0	0	1	0.34	5	PA
TOTAL: MISC. TAXA	54	18.00	46	15.81		
Baetis tricaudatus	120	40.00	115	39.52	4	CG
Diphetor hageni	2	0.67	3	1.03	5	CG
Ephemerella inermis	2	0.67	0	0	4	SC
Tricorythodes minutus	33	11.00	41	14.09	4	CG
TOTAL: EPHEMEROPTERA	157	52.33	159	54.64		
Perlodidae	4	1.33	4	1.37	2	PR
Isoperla	1	0.33	0	0	2	PR
TOTAL: PLECOPTERA	5	1.67	4	1.37		
Amiocentrus aspilus	2	0.67	2	0.69	3	CG
Helicopsyche borealis	2	0.67	6	2.06	3	SC
Hydropsyche	14	4.67	16	5.50	5	CF
TOTAL: TRICHOPTERA	18	6.00	24	8.25		
Optioservus	10	3.33	15	5.15	5	SC
TOTAL: COLEOPTERA	10	3.33	15	5.15		
Simuliidae	7	2.33	1	0.34	6	CF
TOTAL: DIPTERA	7	2.33	1	0.34		
Chironomidae-pupae	7	2.33	6	2.06	6	UN
Chaetocladius	1	0.33	3	1.03	6	CG
Conchapelopia/Thienemannimyia	1	0.33	1	0.34	6	PR
Cricotopus	2	0.67	0	0	7	CG
Eukiefferiella	19	6.33	21	7.22	8	CG
Micropsectra	2	0.67	3	1.03	4	CG
Microtendipes	1	0.33	0	0	6	CG
Orthocladius	4	1.33	1	0.34	6	CG
Pagastia	0	0	1	0.34	1	CG
Parakiefferiella	1	0.33	0	0	6	CG
Paraphaenocladius	3	1.00	3	1.03	4	CG
Polypedilum	6	2.00	1	0.34	6	CG
Rheocricotopus	1	0.33	0	0	4	CG
Rheotanytarsus	0	0	1	0.34	6	CF
Tanytarsus	0	0	1	0.34	6	CF
Tvetenia	1	0.33	0	0	5	CG
TOTAL: CHIRONOMIDAE	49	16.33	42	14.43		
GRAND TOTAL	300	100.00	291	100.00		

Aquatic Macroinvertebrate Data:Big Spring Creek at lower fishing access 7/26/90

Sample:	4.1	4.2
% of sample used:	19	19
Subsample size	300	300
Taxa richness	30	26
EPT richness	9	7
Biotic index	4.98	4.81
% Dominant taxon	40	40
% EPT	60	64
% Collectors (g+f)	78	78
% Scrapers + Shredders	10	11
% Hydropsychinae of Trich	78	67
Metals tolerance index	4.88	4.70
Shannon Diversity (log2)	3.44	3.26
EPT/Chironomidae	3.67	4.45
CTQa	93.35	96.52
%Baetidae of Ephemeroptera	78	74
% Coleoptera	3	5
% Diptera	2	<1
% Chironomidae	16	14
% Ephemeroptera	52	55
% Plecoptera	2	1
% Trichoptera	6	8
% multivoltine	51	50
% univoltine	45	44
% semivoltine	5	6

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	7	3	7	5
Collector-Gatherers	71	17	71	13
Shredders	0	0	0	0
Scrapers	10	4	11	3
Predators	9	5	8	3

Est. total number of organisms	1594	1594
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown

BIG SPRING CREEK:

at Spring Creek Colony 7/26/90	5.1		5.2			
Taxon	#	%	#	%	BI	FFG
Turbellaria	0	0	3	1.00	4	PR
Physella	0	0	1	0.33	8	SC
TOTAL: MISC. TAXA	0	0	4	1.33		
Ophiogomphus	1	0.33	1	0.33	5	PR
TOTAL: ODONATA	1	0.33	1	0.33		
Acentrella	6	2.00	5	1.67	4	CG
Baetis tricaudatus	62	20.67	84	28.00	4	CG
Ephemerella inermis	1	0.33	3	1.00	4	SC
Serratella	0	0	1	0.33	2	CG
Nixe	4	1.33	4	1.33	4	SC
Choroterpes	0	0	2	0.67	2	CG
Tricorythodes minutus	140	46.67	121	40.33	4	CG
TOTAL: EPHEMEROPTERA	213	71.00 220	73.33			
Claassenia sabulosa	0	0	2	0.67	3	PR
Skwala	2	0.67	2	0.67	3	PR
TOTAL: PLECOPTERA	2	0.67	4	1.33		
Amiocentrus aspilus	2	0.67	0	0	3	CG
Helicopsyche borealis	7	2.33	0	0	3	SC
Hydropsyche	18	6.00	13	4.33	5	CF
Lepidostoma-sand case larvae	0	0	1	0.33	1	SH
Nectopsyche	0	0	1	0.33	2	SH
Wormaldia	2	0.67	2	0.67	0	CF
TOTAL: TRICHOPTERA	29	9.67	17	5.67		
Optioservus	7	2.33	6	2.00	5	SC
TOTAL: COLEOPTERA	7	2.33	6	2.00		
Empididae	2	0.67	1	0.33	6	PR
Limnophora	0	0	1	0.33	6	PR
Simuliidae	5	1.67	5	1.67	6	CF
Dicranota	4	1.33	4	1.33	3	PR
TOTAL: DIPTERA	11	3.67	11	3.67		
Chironomidae-pupae	5	1.67	9	3.00	6	UN
Cardiocladius	1	0.33	6	2.00	5	PR
Cricotopus	6	2.00	6	2.00	7	CG
Eukiefferiella	9	3.00	7	2.33	8	CG
Microtendipes	1	0.33	1	0.33	6	CG
Orthocladius	7	2.33	6	2.00	6	CG
Pagastia	0	0	1	0.33	1	CG
Polypedilum	5	1.67	1	0.33	6	CG
Pseudochironomus	2	0.67	0	0	5	CG
Tvetenia	1	0.33	0	0	5	CG
TOTAL: CHIRONOMIDAE	37	12.33	37	12.33		
GRAND TOTAL	300	100.00	300	100.00		

Aquatic Macroinvertebrate Data:Big Spring Creek at Spring Creek Colony 7/26/90

Sample:	5.1	5.2
% of sample used:	22	22
Subsample size	300	300
Taxa richness	23	28
EPT richness	10	13
Biotic index	4.37	4.31
% Dominant taxon	47	40
% EPT	81	80
% Collectors (g+f)	89	85
% Scrapers + Shredders	6	5
% Hydropsychinae of Trich	62	76
Metals tolerance index	4.45	4.57
Shannon Diversity (log2)	2.82	2.93
EPT/Chironomidae	6.59	6.51
CTQa	81.29	78.86
%Baetidae of Ephemeroptera	32	40
% Coleoptera	2	2
% Diptera	4	4
% Chironomidae	12	12
% Ephemeroptera	71	73
% Plecoptera	1	1
% Trichoptera	10	6
% multivoltine	28	34
% univoltine	70	63
% semivoltine	3	3

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	8	3	7	3
Collector-Gatherers	80	11	78	11
Shredders	0	0	1	2
Scrapers	6	4	5	4
Predators	3	5	7	8

Est. total number of organisms	1350	1350
Est. number collected per foot	unknown	unknown
Est. number collected per minute	unknown	unknown